# **SIEMENS**

# **MOBILETT XP**

SP

# **Troubleshooting Guide**

System

**Troubleshooting Guide** 

#### Valid for

- MOBILETT XP
- MOBILETT XP Eco
- MOBILETT XP Hybrid
- MOBILETT XP Digital

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#### **Document revision level**

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### Performance of work



Any technician duly assigned by the local Siemens office is authorized to perform maintenance and service work.

Certain tasks may also be performed by other technical personnel (e.g. the customer's hospital technicians). These tasks are marked by the icon shown here.

In such cases it is absolutely necessary:

- to observe all instructions in the text and graphics;
- to use the specified tools, test equipment and aids.

You can also contact your national Siemens Uptime Service Center for support.

## **Special notes**

**⚠ DANGER** 

DANGER indicates an immediate danger that if disregarded will cause death or serious physical injury.

口)

**∆WARNING** 

WARNING indicates a possible danger that if disregarded can cause death or serious physical injury.

₽

**∆CAUTION** 

CAUTION used with the safety alert symbol indicates a possible danger that if disregarded will or can lead to minor or moderate physical injury and/or damage to property.

**口** 

**NOTICE** 

NOTICE used without the safety alert symbol indicates a possible danger that if disregarded can or will lead to an undesirable outcome or state other than death, physical injury or property damage.

**戊**〉

NOTE

NOTE is used to indicate information that explains the proper way to use devices or to carry out a process, i.e., provides pointers and tips.

#### **Icons**



Warning about ionizing radiation or radioactive substances. Tests and adjustments that must be performed with the radiation switched on are indicated by this radiation warning icon.



Dangerous electrical voltage > 25 VAC or > 60 VDC.



Caution! General hazard warning.



ESD: Warning about electrostatically sensitive components.



Report icon. Used to indicate entries in certificates.



Certain tasks can also be performed by other technical personnel (e.g. the customer's hospital technicians).

U S

Certain sections apply only to the USA. These sections are marked with this icon.

Fig. 1:

## **Product-specific safety measures**



While performing maintenance and service work on the MOBILETT XP/Eco/Hybrid/Digital with the covers removed, it is possible to come into contact with components under voltage. Carelessness can result in death or serious bodily injury.

When performing maintenance and service work, the following is to be observed:

- the product-specific safety information contained in the technical documentation,
- □ and the general safety information (TD00-000.860.01...).

## **⚠ DANGER**

Remove or install components only if:

- → The system is switched off, and
- The capacitors are discharged, and
- The batteries have been disconnected.



#### Releasing radiation:

- □ Checks and settings for which radiation must be released are to be marked with the radiation warning symbol.
- □ Radiation protection measures are to be used.

### **⚠ DANGER**

To avoid electrical shock from components under voltage, also be aware that:

The capacitors of the capacitor bank can be electrically charged even when the system is switched off and the power cable is disconnected!

In the case of an error, individual capacitors of the capacitor bank can still be electrically charged when disconnected from the charging circuit!

Disconnect the battery blocks in the XP Hybrid/Digital prior to maintenance and service work!

Carelessness can result in death or serious bodily injury.

- □ Do not touch potentially dangerous components(Fig. 2 / p. 10)
- □ If loose parts must be removed from the unit, use only insulated tools:
- □ Protect the work area so that no other persons are able touch the unit while the covers are open or removed!
- Switch the unit off before servicing or maintenance. Always disconnect the power plug first.
- XP Hybrid: Make sure that the main switch and the battery mode are switched off.
- The capacitor bank discharges to < 40 V in approx. 15 minutes.</li>
  - The safety covers can be removed after this period has elapsed.
- Prior to performing any work, it must be verified that areas with dangerous voltage are voltage-free (Fig. 2 / p. 10).

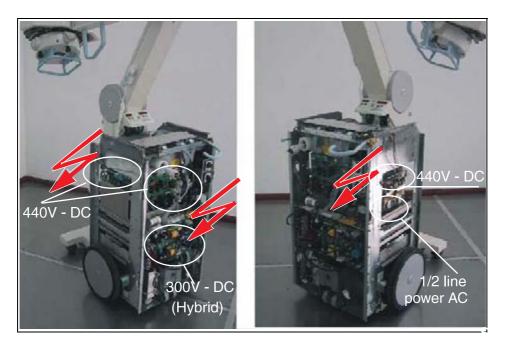


Fig. 2: Locations with dangerous voltage Explanation of (Fig. 2 / p. 10):



Covers and safety covers are removed:

Back:

CAUTION: DC voltage (440V) at the capacitor bank (D927)

Left:

CAUTION: DC voltage (440V) directly at the capacitor bank!

Right:

CAUTION: DC voltage (440V) directly at the capacitor bank!

CAUTION: AC voltage (> 100V ~or > 60V ~ = half line voltage) at power supplies U1 and U2 as long as the power cord is connected.

Additionally for XP Hybrid/XP Digital:

CAUTION: DC voltage (300 V) from the battery block to PCB D982! Always disconnect the battery plug from BK1-BK4.

# System overview - user

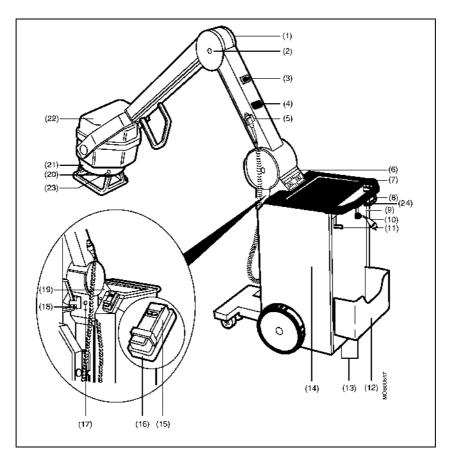


Fig. 3: User overview\_01

(1) Hanger for lead apron	(13) Castors	
(2) Articulated arm	(14) Console with chassis	
(3) Sensor for IR remote control (optional)	(15) IR remote control (optional)	
(4) DAP display (optional)	(16) Holder for IR remote control (optional)	
(5) Exposure switch (S27)	(17) Potential equalization connector	
(6) Control panel and display field	(18) Transport safety device	
(7) Transport handle	(19) Stand column	
(8) Hand/parking brake handle	(20) Multileaf collimator	
(9) Main switch	(21) DAP ionization chamber (optional)	
(10) Power cord	(22) X-ray tube assembly	
(11) Brake handle for cable winch	(23) Light localizer buttons (two sides)	
(12) Cassette compartment	(24) Motor control (Hybrid)	

## Orientation

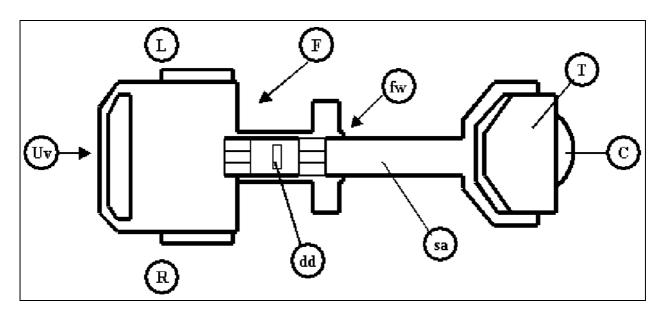


Fig. 4: Top view of system\_01

System orientation to clarify the technical description		
Abbreviations	Explanation	
Uv	User view - back ( <b>U</b> ser <b>v</b> iew)	
L	Left side of unit (left)	
R	Right side of unit (right)	
F	Front (front)	
fw	Front wheels (front wheels)	
sa	Support arm (support arm)	
Т	Tube (single tank)	
С	Multileaf collimator (collimator)	
dd	DAP display (dose display)	

NOTE

These orientation indicators are used in all technical documents. Descriptions are always from the "forward travel" user view. Always reference these indicators when communicating with third parties (e.g., USC/HSC).

## System overview - MOBILETT XP/Eco/Hybrid service

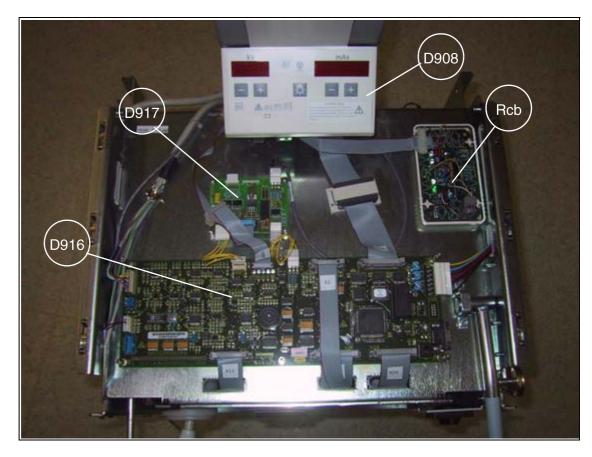


Fig. 5: Top view\_01

Common parts of MOBILETT XP, Eco and Hybrid		
Abbreviations	Explanation	
D908	User display and control	
D916	CPU board	
D917	Galvanic separation for S27/DAP/Remote	
Rcb	Remote control board (remote control option)	

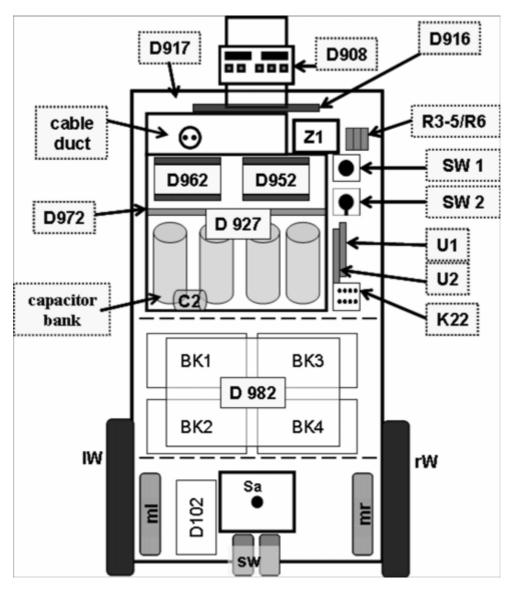


Fig. 6: Schematic overview of XP, Eco, Hybrid

Common parts of MOBILETT XP, Eco and Hybrid		
Abbreviations	Explanation	
SW1	Key switch, Power ON/OFF	
Z1	Line filter	
C1 (R1)	Capacitor for inverter with discharge resistor (front left side / not shown here)	
C2 (R2)	Starter capacitor with discharge resistor	
R3 - 5 / R6	R3-R5 internal discharge resistor capacitor bank	
(Front right)	R6 separate discharge resistor for Service	
Capacitor block	12 x 10 mF capacitors, mounted with D972	
K22	Main relay	

MOBILETT XP

$+5V$ / $\pm$ 15V power supply		
+24V power supply		
Power Supply		
Charging board capacitor bank (behind D927)		
kV inverter (behind D927)		
Capacitor bank board (behind D927)		
Support arm adjusting spring		
Castors		
Additional components for MOBILETT XP Hybrid only		
Op. mode selector (battery / off / power)		
Battery charger		
Motor drive control		
Battery block, left		
Battery block, right		
Motor right / motor left		
Optional parts for MOBILETT XP; Eco and XP Hybrid (not pictured)		
Dose area product measuring chamber (mounted on the collimator)		
DAP adapter board (mounted in the collimator cover)		
DAP display board (mounted in the lower arm segment cover)		

## System overview - MOBILETT XP Digital service

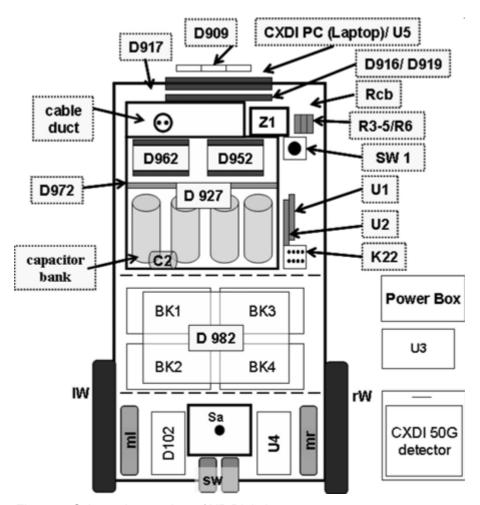


Fig. 7: Schematic overview of XP Digital

MOBILETT XP Digital parts		
Abbreviations	Explanation	
D916/D919	CPU board/X-ray interface	
D917	Galvanic separation for S27/DAP/remote	
Rcb	Remote control board (remote control option)	
SW1	Key switch, power ON/OFF	
Z1	Line filter	
C1 (R1)	Capacitor for inverter with discharge resistor (front left side/not shown here)	
C2 (R2)	Starter capacitor with discharge resistor	
R3-R5, R6 (X9)	Discharge resistor capacitor bank (front right side)	
Capacitor bank	12 x 10 mF capacitors, mounted on D972	
K22	Main relay	

D909	X-ray display and keyboard	
U1	+5V/± 15V power supply	
U2	+24V power supply	
D927	Power supply	
D952	Capacitor bank charging board (behind D927)	
D962	kV inverter (behind D927)	
D972	Capacitor bank board (behind D927)	
Sa	Support arm adjusting spring	
lw/rw/sw	Support rollers and back wheels	
D982	Battery charger	
D102	Motor drive control	
BK1/BK2	Battery block, left	
BK3/BK4	Battery block, right	
mr/ml	Motor right/motor left	
CXDI PC	Laptop for the imaging system	
CXDI detector	CXDI flat detector	
Power box	Connecting unit between CXDI PC and CXDI detector	
U3	DC converter 300V DC/24V DC	
U4	Inverter 24V DC/220V AC	
U5	Power supply CXDI PC (laptop)	
Optional parts for MOBILETT XP Digital (not shown in illustration)		
DAP chamber	Dose area product measuring chamber	
D991	DAP adapter (inside the collimator cover)	
DAP display	DAP display board (mounted in the lower arm segment cover)	

## **Required Documents**

Operator Manual	SPR8-230.621
Wiring Diagram	SPR8-230.621
Instructions for installation and startup	SPR8-230.814
Replacement of Parts	SPR8-230.841
Disposal instructions	SPR8-230.861

## Required tools, test equipment and aids

- Standard service tool kit
- Digital multimeter
- 2-channel storage oscilloscope with ± -2.5% accuracy
- Ground wire test meter

## **Product-specific safety measures**

Prior to beginning system work, be aware:



Danger of life-threatening electric shocks.

When performing maintenance or service work on the MOBILETT XP/Eco/Hybrid/Digital with the covers removed, it is possible to come into contact with components under voltage.

Carelessness can result in death or serious bodily injury.

- □⇒ Before starting work with open covers, secure the working area so that no other persons can come into contact with the system.
- Remove safety covers only if absolutely necessary to perform a task. Then refit the cover correctly.
- □⇒ Never leave the system unattended without safety covers. Do not employ any helpers without technical instruction. THINK CAREFULLY BEFORE TOUCHING ANY PART OF THE SYSTEM!
- □ When performing measurements and troubleshooting under voltage, comply with the general safety regulations for such work.
- □ Use the discharge resistor to safely discharge non-discharged capacitors.
- ⇔ Secure the system via the brake.

## Flow chart - troubleshooting

**NOTE** 

The following charts serve exclusively as guidelines for the procedure for testing the elements or components. The associated work steps and safety measures are not described in these charts.

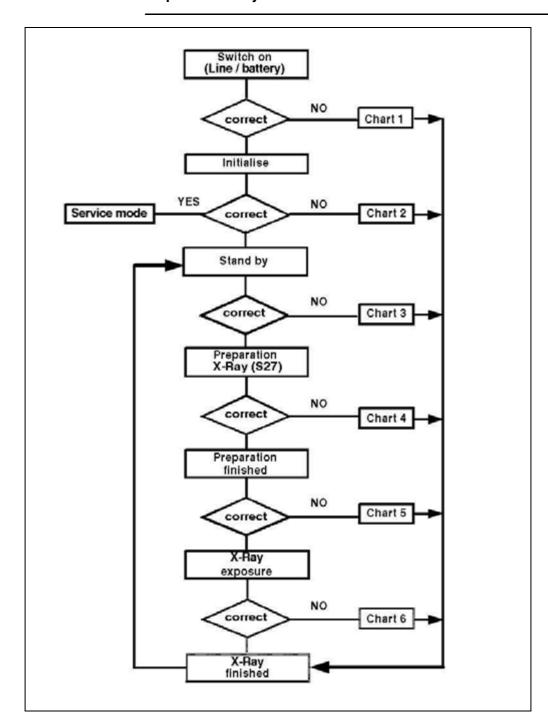


Fig. 8: Troubleshooting\_Procedure diagram\_

#### Chart 1

#### Starting the "initialization phase":

In the case of initialization errors, the following points must be checked:

- Power socket, power supply available, e.g., 220 V AC
- Only for XP Hybrid/XP Digital: Battery charge battery status display available
- Check power cable/plug cable winch line filter
- Main switch SW1, relay K22
- Check fuses F7/F8 on board D927
- Hybrid only: Check operating mode switch SW2
- Hybrid/Digital only: Check fuses F1 and F2 on battery charger D982.
- Check power supply U2:
  - In the case of XP (Eco): the input voltage of power supply U2 = power input voltage (AC).
  - In the case of XP Hybrid:
    - the input voltage of power supply U2 = power input voltage (AC) or = battery voltage (DC) (depending on the position of operating mode switch SW2)
  - In the case of XP Digital:
    - the input voltage of power supply U2 = battery voltage (DC)
  - Check fuse F1 of power supply U2
  - Check the cable connection between power supply U2 and D927
  - Check fuse F3 of board D927
  - Check the connections between D927 and D916
     (24 V DC: D916 plug X2 pin 5-7 & pin 9-8)
- Check power supply U1:
  - In the case of XP (Eco): the input voltage of power supply U1 = power input voltage (AC)
  - In the case of XP Hybrid:
    - the input voltage of power supply U1 = power input voltage (AC) or = battery voltage (DC) (depending on the position of operating mode switch SW2)
  - In the case of XP Digital:
    - the input voltage of power supply U1 = battery voltage (DC)
  - Check fuse F1 of power supply U1
  - Check the cable connection between power supply U2 and D916
     D916 X15 pin 4-3 +5 V DC; X15 pin 5-6 +15 V and X15 pin 6-7 -15 V DC
- Check power supply U3 (only for XP Digital):
  - the input voltage of power supply U3 = battery voltage (DC), and the output voltage is 24 V (DC)
- Check power supply U4 (only for XP Digital):
  - the input voltage of power supply U4 = the output voltage of power supply U3, 24 V (DC), the output voltage is 220 V (AC), power supply for CXDI PC and the touchscreen display

D916 may be defective, check D916 (see chart 2)

#### Chart 2

#### Initialization phase of D916 (CPU):

The system starts in the normal operating mode.

Initialization is correctly completed if the system displays the default kV and mAs values in user mode.

If initialization is interrupted, the following error messages may be displayed:

- ERR 92 RAM error
- ERR 93 voltage error of +15 Vcc
- ERR 96 kV converter error
- ERR 97 mA converter error
- ERR 98 J<sub>h</sub> converter error

#### Checking D916 in the service mode

NOTE

Radiation cannot be released in the service mode.

Switch on the service mode on D916:

- Move switch SW2B to position 2 (service)
- Activate SW3

Initialization phase of D916:

- Initialization of the microcontroller register
- Initialization of the periphery
- Variable initialization
- Internal A/D channel check
- Start of the internal hardware monitoring
- RAM value check

Initialization has been completed correctly when "Pr 1" is shown on the display.

If initialization is interrupted, D916 may be defective.

The following error messages are possible:

- ERR 92 RAM error
- ERR 93 voltage error of +15 Vcc
- ERR 96 kV converter error
- ERR 97 mA converter error
- ERR 98 J<sub>h</sub> converter error

#### Chart 3

#### "Standby operation"

The following functions are checked:

- Internal hardware monitoring on D916
- Monitoring of the supply voltage
- Monitoring of the oil pressure and temperature lines
- Monitoring of the short-circuit inverter lines (main inverter/filament inverter)
- Monitoring of the capacitor voltage
- Controlling of the capacitor charger
- Hybrid/Digital only: Monitoring the battery voltage
- kV and mAs can be selected via the keyboard (only for XP Digital in the manual mode).

If the above functions are correct, exposure switch S27 can be set to "exposure preparation".

On failure of the above functions, the standby mode is interrupted. The system must be restarted.

The following error messages are possible:

- ERR 1 error value of +15 V
- ERR 3 oil pressure high or tube overheated
- ERR 4 static short-circuit at the main inverter
- ERR 6 Ih < I preheat (filament current error)
- ERR 7 lh > I preheat (filament current error)
- ERR 8 static kV measured value <> 0
- ERR 9 static mA measured value <> 0
- ERR 10 battery voltage <= 125 V or defect in a battery pack
- ERR 11 voltage at the capacitor bank too high
- ERR 12 short-circuit signal at the filament inverter
- ERR 13 low voltage at the capacitor bank
- ERR 14 battery/charger switching error
- ERR 15 static short-circuit at the filament inverter

#### Chart 4

#### "Preparation" for exposure release

The following functions are checked and/or performed:

- Query of all standby functions (see chart 3)
- Start of rotating anode rotation
- Start of preheating (pushing) of tube filament heating
- Start of monitoring of the filament circuit
- Start of monitoring of the exposure switch

If the above functions are correct, the "conclude preparation" function follows (see chart 5).

Preparation is interrupted if one of these functions fails.

The following error messages are possible:

- ERR 22 short-circuit at the filament inverter
- ERR 23 limitation of the filament current
- ERR 24 anode does not rotate
- ERR 25 preparation > 20 seconds
- ERR 28 short-circuit at the starter
- ERR 41 exposure not completed

#### Chart 5

#### "Conclude preparation"

The following functions are checked and/or performed:

- Query S27 in the "Preparation" position
- Query of the filament inverter
- Query of the filament current / kV/mAs preselection
- Query of the rotating anode starter
- Query of the anode rotation (current measurement of the stator windings)
- Start of the "maximum preparation time" function (preheating max. 20 sec)
- Acoustic signal 2.5 sec after the "preparation" start

If the above functions are correct, an "exposure" can be released via S27 within 20 sec after the acoustic signal.

Preparation is interrupted if one of these functions fails.

The following error messages are possible:

- ERR 22 short-circuit at the filament inverter
- ERR 23 limitation of the filament current
- ERR 24 anode does not rotate
- ERR 25 preparation > 20 seconds
- ERR 28 short-circuit in the starter
- ERR 41 exposure not completed

#### **Chart 6**

#### "Exposure release"

The following functions are checked and/or performed:

- Starting of the HV inverter
- Monitoring and controlling of the actual tube current
- Monitoring and controlling of the high-voltage
- Change after exposure into standby mode
- Anode braking

If the exposure is interrupted, the following error messages are possible:

- ERR 31 kV limitation
- ERR 34 tube current limitation
- ERR 35 short-circuit at the main inverter
- ERR 36 short-circuit at the filament inverter
- ERR 37 error in the kV control loop
- ERR 38 error in the mA control loop
- ERR 39 timeout "t-max exposure"
- ERR 41 exposure not completed
- ERR 42 filament current exceeds permissible limit

## **Overviews**

## D916 (CPU)

### LEDs, potentiometer, switch

Name	Function / information	Value / comment	
V24	Flashes when software is running	n.a.	
P1	Adjustment of the mAs counter	Only in factory (do not change)	
P3	Adjustment of the max. frequency of the filament inverter	75 kHz ± 2 kHz	
		(Test point TP - FC1)	
		(See the "Filament circuit" section)	
P4	Adjustment of the max. frequency of the main inverter	Service program 7:	
		50 kHz $\pm$ 0.5 kHz	
		(Test point TP - FC2)	
P5	Preheating adjustment	Presetting, test point TP - 1: 7.5 kHz ± 1kHz	
		Setting, test point TP - JR	
SW2B	Mode selection:	Normal mode: Position 1	
	To change the mode, switch SW2B, switch the system off and on again, or press reset button SW3.	Service mode: Position 2	
SW3	Reset button	n.a.	

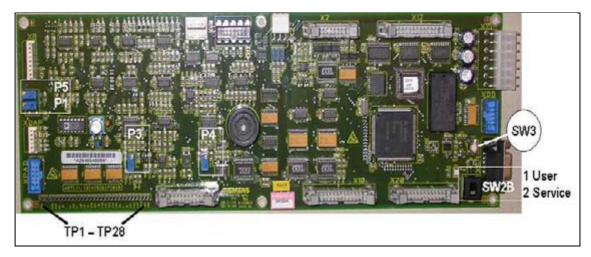


Fig. 9: CPU D916

## Test points D916 (CPU)

SP	Name	Function / information	Test ratio
1	GND	0V signal (ground)	n.a.
2	GND	0V signal (ground)	n.a.
3	KVN	kV actual, negative	1 V ^ 10 kV
4	KVP	kV actual, positive	1 V ^ 10 kV
5	KV	kV actual, total	1 V ^ 30 kV
6	JR	mA actual, tube current (mA)	1 V ^ 100 mA
7	I	Primary resonant filament current (can be measured only with the oscilloscope)	1 V ^ 1 A
8	IH	Actual effective filament current	1 V ^ 2 A
9	SWT	Main inverter control circuit (high = kV actual > 70%)	n.a.
10	F1	mAs integration	100mA ^ 16 kHz
11	TEMP	Single tank temperature (analog/neg. coefficient)	> 2 V = > 60°C
12	VR	+5 V - DC, U1	± 0,01
13	VC	Capacitor bank voltage	1 V ^ 100 V
14	SCM	Main inverter short-circuit (high = error, e.g.: ERR 22)	n.a.
15	SCH	Filament inverter short-circuit (high = error, e.g.: ERR 36)	n.a.
16	JIM	Overcurrent error (filament or tube current), (high = error, e.g.: ERR 23/ERR 42)	n.a.
17	KVM	Overvoltage error (+/- kV), (high = error, e.g.: ERR 31)	n.a.
18	KVC	Main inverter resonant current	1 V ^ 50 A
19	VSA	Not used	n.a.
20	KVS	kV nominal (kV)	1 V ^ 30 kV
21	JRS	Nominal tube current (mA)	1 V ^ 100 mA
22	IHS	Nominal effective filament current	1 V ^ 2 A
23	l1	Motor current (stator winding 1)	1 V ^ 4 A
24	12	Motor current (stator winding 2)	1 V ^ 4 A
25	FC1	Filament inverter (kHz)	n.a.
26	FC2	Main inverter (kHz)	n.a.

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27	EXP	Main inverter status (high = standby, low = exposure in progress)	n.a.
28	ERAR	Stator start signal (high = error, e.g.: ERR 28)	n.a.

## D927 (power supply)

### Potentiometer, LEDs

Name	Function / information	Value
P1	Collimator voltage control	Setting at >180 lux in light field ^ approx.
		25 V at connection X7
V7	+15 V DC present	LED "on"
V8	+24 V DC activated	LED "on" = U2 "on", line voltage present
V18	Filament circuit	LED "on" = intermediate circuit voltage present
V26	Line voltage/battery voltage present	LED "on"
V63, V53	Rotating anode starter	LED "on" = intermediate circuit voltage present
V54	Light localizer	LED "on" = supply voltage present

#### **Fuses**

Fuse	Value	Comments
F3	1 A (250V~/ slow)	Switch-on circuit
F5	6 A (500 V DC/ fast)	Capacitor bank intermediate circuit
F6	20 A (500 V DC/ fast)	Capacitor charger
F7	15 A (250V~/ slow)	Line voltage
F8	15 A (250V~/ slow)	Line voltage

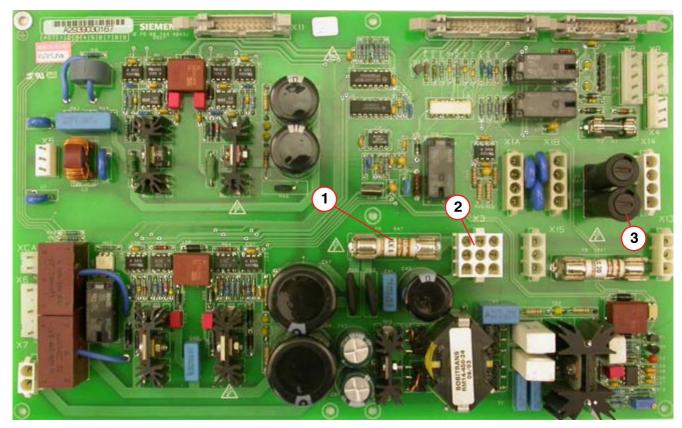


Fig. 10: D927
Pos. 1 F5
Pos. 2 X3
Pos. 3 F7/F8

## U1/U2 (voltage supply DC)

### **Test points**

Name	Function / information
U1	+5 V & +/-15 V (output: K2)
U2	+24 V (output: K1)

## U3/U4 (voltage supply only for XP Digital (imaging system))

### **Test points**

Name	Function / information
U3	+300 V DC/ +24 V DC
U4	+24 V/220 V AC

## D972 (capacitor bank)

#### **LEDs**

Name	Function / information	Value
V1-12	Charge voltage C1-C12 (10 mF)	LED "ON" (yellow), charge voltage > 40 V

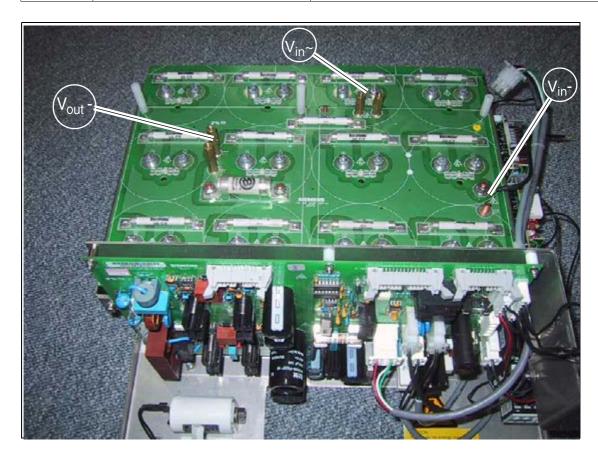


Fig. 11: Board D972 capacitor block

#### **Fuses**

Fuse	Value	Comments
F1-F12	20 A (500 V DC/ fast)	Capacitors C1-C12
F13	20 A (500 V DC/ fast)	Capacitor bank input
F14	80 A (500 V DC/super fast)	Capacitor bank output

## D952 (capacitor bank charger)

### LEDs, fuse

Name	Function / information	Value
V25	Input voltage ok (Mains battery)	LED "on"
V30	Output voltage ok	LED "on"
F1	Input fuse for D927	10 A (250 V~/slow)

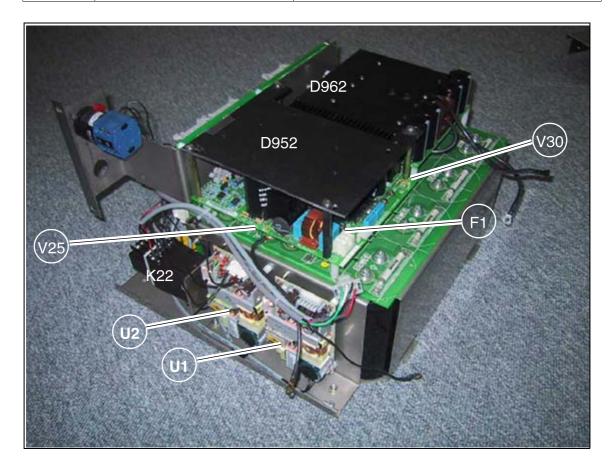


Fig. 12: Board D952 (view with capacitor bank dismantled)

### D962 (kV - inverter board)

The kV inverter does not include any displays, fuses, or test points relevant to trouble-shooting.

## D982 (battery charger)

#### Fuses D982

Fuse	Function / information	Value
F1-F2	Input alternating current voltage	6 A (230 V~/slow)
F3	Charger 2 - output voltage	2.5 A (500 V DC/fast)
F4	Charger 1 - output voltage	2.5 A (500 V DC/fast)
F5	300 V output to capacitor block	40 A (500 V DC/fast)

#### LEDs and potentiometer of charger 1

The following table applies for charging operation (power line connected).

Charger 1 (charges BK1 and BK2)		
Name	Function / information	Value
V46	Trickle charge (U <sub>bat</sub> >80V<120V)	LED on
V42	Charging process (U <sub>bat</sub> >120V<170V)	LED on
V82+V46 +V42	Batteries completely charged (power line disconnected)	All LEDs off
V85	Floating	LED on
V82+V46	Defective batteries in BK1 or BK2; or fuse F4 blew	LED on
V33	Charger 1 is working; voltage present at output (approx. 175 V max.)	LED on
P9	Output voltage (BK1 & BK2)	Factory-only setting

#### LEDs and potentiometer of charger 2

The following table applies for charging operation (power line connected).

Charger 2 (charges BK3 and BK4)			
Name	Function / information	Value	
V40	Trickle charge (U <sub>bat</sub> >80V<120V)	LED on	
V39	Charging process (U <sub>bat</sub> >120V<170V)	LED on	
V80+V40 +V39	Batteries fully charged (Power line disconnected)	All LEDs off	
V84	Floating	LED on	

V80+V40	Defective batteries in BK1 or BK2; or fuse F3 blew	LED on
V34	Charger 2 is working; voltage present at output (approx. 175 V max.)	LED on
P7	Output voltage (BK3 & BK4)	Factory-only setting

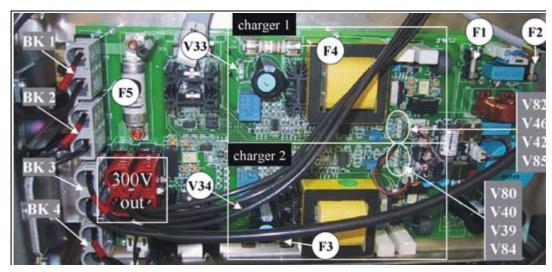


Fig. 13: D982 Battery charger\_\_

## D102 (motor control)

### Potentiometer, fuse

Name	Function / information	Value
P1	Speed setting	Factory-only setting
F1	Input 300 V (DC)	3.15 A fast



Fig. 14: D102 (motor control)

## **Error messages**

USE 01	User message 01
System status:	Explanation: If the exposure time from the digital application software (parameter kV, mAs, mA) is < 1 sec but the calculated exposure time of the generator is > 1 sec, the USE 01 message is displayed.
Standby	<ul> <li>Action:</li> <li>Due to a possible faulty exposure, the mA value in the digital application software is to be reduced.</li> </ul>

ERR 1	Error value +15 V	
System status:	Explanation: D916 (CPU) faulty recording of +15 V DC. System cannot be switched on.	
	Action:	
Standby	Check D916 (CPU). X15.5-6 voltage "+15 V" from power supply U1.	

ERR 3	Oil pressure too high or tube too hot	
System mode:	Explanation: Oil pressure switch or temperature sensor of the single tank activated.	
	Action:	
Standby	Allow single tank to cool prior to check.	
	Check the connections and cable between D916 (CPU X8.9/X8.8 and oil pressure switch/temperature switch on the single tank (K2).	

ERR 4	Static short-circuit at main inverter D962
System mode:	Explanation: D916 (CPU) detected main inverter short-circuit (D962).  Action:
Standby	Check D962: Switch system off, wait 15 minutes (capacitor discharge time!), disconnect the cable connection at C1, switch the system on again.
	<ul> <li>If ERR 4 is displayed again, D962 must be replaced.</li> <li>If ERR 4 is not displayed again, the problem is in the single tank, capacitor C1, or the cable connection/plug to the single tank.</li> </ul>

ERR 6	Ih < I preheat (filament current error)
System mode:	Explanation: The instantaneous filament current (test point IH) is less than the specified nominal value (test point IHS) of the microcontoller (D916).
	Action:
Standby	Check the resonant filament current (D916; TP-I), the filament current (D916, TP-IH), and the nominal filament current value (D916, TP-IHS). IH and IHS must be the same. (Further information is available in the "Filament circuit" section of this document).
	Possible causes: Defective cable/contacts between D927 (X5) and the single tank; fuse F5 blown on D927; D927; D916; ribbon cable X11 (D927-D916); single tank (heating coil, filament transformer).

ERR 7	Ih > I preheat (filament current error)
System mode:	Explanation: The instantaneous filament current (test point IH) is greater than the specified nominal value (test point IHS) of the microcontoller (D916).
Standby	Action:
	Check the resonant filament current (D916; TP-I), the filament current (D916, TP-IH), and the nominal filament current value (D916, TP-IHS). IH and IHS must be the same. (Further information is available in the "Filament circuit" section of this document).
	Possible causes: D927; D916.
	Rare causes: Defective cable/contacts between D927 (X5) and the single tank; fuse F5 blown on D927; ribbon cable X11 (D927-D916); single tank (heating coil, filament transformer).

ERR 8	Static kV measured value <> 0
System	Declaration: D916 detects actual kV error.
mode:	Action:
Standby	Check the cable connection of measurement data log D907, the single tank, and D916.X8 (CPU).
	Possible causes: Defective single tank, defective cable, defective D916 (CPU).

ERR 9	Static kV measured value (tube current) <> 0
System mode:	Explanation: A tube current is detected during stand-by. D916 (CPU) detects actual mA error.
	Action:
Standby	Check the cable connection between measurement data log D907 (the single tank) and D916.X8 (CPU).
	Possible causes: Cable connection between the single tank and D916 (X8); "ground connection" from the system to the single tank is defective; D916; D907; single tank.

ERR 10	Defect in a battery pack
System mode:	Explanation: D916 (CPU) detects via D982 a battery pack with a voltage <= 125V or a defective battery pack.
	Action:
Standby	Check the battery voltage, nominal value > 125 V, possibly charge battery.
	Check fuse F5 on D982 (battery block output).
	Check fuse F3 on D982 (charger 1).
	Check fuse F4 on D982 (charger 2).
	Check the cable connection between the battery blocks and D982.
	Check the cable/contacts between the individual batteries.

ERR 11	Capacitor bank voltage too high
System mode:	Explanation: D916 (CPU) detects voltage too high (> 460 V) on the capacitor bank.
	Action:
Standby	Check measurement point TP-VC on D916 (capacitor bank voltage)
	Possible causes: D952
	Rare causes: Cable connection X20 (D916-D952-D962); D916

ERR 12	Short-circuit signal at the filament inverter (D927)
System mode:	Explanation: Permanent short-circuit in the filament inverter during stand-by (test point D916, TP SCH).
	Action:
Standby	<ul> <li>Check test point TP - SCH on D916 (CPU) (high = error, short-circuit is detected).</li> </ul>
	Check the cable connection between D916.X11 (CPU) and board D927.
	Check D916 (CPU): Switch off the system, disconnect plug X5 of board D927, switch the system on again.
	☐⇒ If ERR 12 continues to be displayed, D916 is to be replaced.
	•
	Possible defects: Cable connection X11 (D927-D916); D916 (CPU); D927.

ERR 13	Capacitor bank voltage too low
System	Explanation: D916 (CPU) detects a capacitor bank voltage that is too low.
mode:	Action:
Standby	Check the connection between D916 (CPU) and D952.X20, connection between D927 and D952 (X3).
	Check the voltage at capacitor block TP - Vc on D916 (CPU) approx. 4.4 V DC and at fuse F5 on D927 approx. 440 V DC. (Measurement factor 1:100)
	Format the capacitor bank using service program 1, (ERR 13 is also output for an excessive leakage current of one or more capacitors).
	Possible defects: D916, D952, D972, C1-C12,

ERR 14	Battery/charger - switching error
System	Explanation: D916 (CPU) detects a battery charge error.
mode:	Action:
	Check cable connections D982 X2-D916 (CPU) X2.
Standby	D982 defective.
	Possible defects: D982, D916 (CPU)

ERR 15	Static short-circuit at the filament inverter
System mode:	Explanation: Noise in the filament inverter short-circuit signal (test point D916, TP SCH) during stand-by.
	Action:
Standby	<ul> <li>Check test point TP - SCH on D916 (CPU) (high = error, short-circuit is detected).</li> </ul>
	<ul> <li>Check D927: Switch off the system, disconnect cable X5 of board D927, switch the system on again.</li> </ul>
	□     □
	Possible defects: Cable connection X11 (D927-D916); D916 (CPU); D927.

ERR 22	Short-circuit at the filament inverter
System mode:	Explanation: Short-circuit in the filament inverter during "preparation" (test point D916, TP SCH).
	Action:
Preparation	• Check test point TP - SCH on D916 (CPU) (high = error, short-circuit is detected).
	• Check D927: Switch off the system, disconnect cable X5 of board D927, switch the system on again.
	If ERR 22 continues to be displayed, check D916 (see ERR 12) or replace D927.
	Possible defects: D916; D927.

ERR 23	Filament current exceeds permissible limit
System mode:	Explanation: D916 (CPU) detects that the filament current exceeds the permissible limit during "preparation" (test point D916, TP JIM).
	Action:
Preparation	• Check test point TP - JIM on D916 (CPU) (high = error).
	<ul> <li>Check the filament current values for the preparation phase. (Possibly too high or too low). Adjust potentiometer P5 on D916 (CPU).</li> </ul>
	Possible defects: D916; D907.

ERR 24	Anode does not rotate
System mode:	Explanation: D916 (CPU) detects no or insufficient anode rotation in the start phase.
	Action:
Preparation	Check fuse F5 on board D927.
	Check fuse F6 on board D927.
	Check the cable connection between the single tank and D927.
	Check the cable connections to phase shift capacitor C2.
	Check the cable connection between boards D927 X11 and D916 X11.
	Measure stator winding TP - I1 and I2 on D916. (Also see ERR 28)

ERR 25	Timeout in preparation
System mode:	Explanation: D916 (CPU) detects a timeout during preparation when the preparation button is pressed for longer than 20 seconds without exposure release.
Preparation	Action:
	If this error occurs without the hand switch having been pressed longer than 20 seconds, test the connection between the CPU and hand switch. The hand switch or D916 may be defective.

ERR 28	Short-circuit at the starter
System mode:	Explanation: D916 (CPU) detects a short-circuit of the starter.
	Action:
Preparation	Check phase shift capacitor (C2).
	<ul> <li>Check the resistance at the stator winding (between X6-3 and X6-1 approx. 5 Ohms; between X6-3 and X6-5 approx. 9 Ohms) in the switched-off state.</li> </ul>
	Possible defects: D927, C2, cable connection to the single tank, single tank.

ERR 31	kV exceeds permissible limit
System mode:	Explanation: D916 (CPU) detects max. kV.
	Action:
Exposure	• Check the test point "overvoltage error" TP - KVM on D916 (CPU), (high = error) after exposure.
	Check the cable connection between the single tank and D916.
	<ul> <li>Check the highest frequency of the main inverter, test point FC2 on D916 (CPU).</li> </ul>
	Check the filament current.
	Possible defects: D916, D907; single tank.

ERR 34	Tube current exceeds permissible limit
System mode:	Explanation: D916 (CPU) detects I <sub>JR</sub> max. during an exposure (test point D916, TP JIM).
	Action:
Exposure	• Check test point TP - JIM on D916 (CPU), (high = error).
	Check the filament current with preparation. Set potentiometer P5 (filament current during preparation).
	Sporadic error message - check the highest frequency of the filament inverter.
	Possible defects: D916, D907.

ERR 35	Short-circuit at the main inverter
System mode:	Explanation: D916 (CPU) detects a main inverter short-circuit.
	Action:
Exposure	<ul> <li>Check test point TP - SCM on D916 (CPU) after exposure, (high = error).</li> </ul>
	<ul> <li>ERR 35 with exposures in all kV ranges indicates a probable single tank defect.</li> </ul>
	Check the cable connections between D916 and D962 (X20).
	• Check the cable connections between D962 and the single tank (U - V).
	Check C1.

ERR 36	Short-circuit at the filament inverter
System mode:	Explanation: D916 (CPU) detects a short-circuit at the filament inverter during an exposure.
	Action:
Exposure	<ul> <li>Check test point TP - SCH on D916 (CPU) (high = error, short-circuit is detected).</li> </ul>
	Check the maximum heating rate at TP - FC1, D916 (CPU)
	<ul> <li>Check the connections between D927 (X5) and the single tank (terminals 11 and 12).</li> </ul>
	Possible defects: D927, D916.

ERR 37	Error in the kV control loop
System mode:	Explanation: D916 (CPU) detects an error in the kV control loop.  Action:
Exposure	The value KV <sub>actual</sub> (TP-KV) does not agree with the value KV <sub>nominal</sub> (TP-KVS).
	Check the cable connections between D962, C1 and the single tank, and between D916 (X8) and the single, D907.
	Check the capacitors of the capacitor bank, all LEDs must light on D972 when the MOBILETT XP is "on".
	Possible defects: Fuse F1F12, F14 (80A) on D972; C1C12 D972, D962; D907; D916; C1 resonance capacitor.

ERR 38	Error in the mA control loop
System mode:	Declaration: D916 (CPU) detects an error in the mA control loop (test point D916 (TP - JR) and (TP - JRS).
	Action:
Exposure	Check the maximum frequency of filament inverter FC1.
	<ul> <li>Ensure that value I<sub>actual</sub> (JR) agrees with value I<sub>target</sub> (JRS).</li> </ul>
	Check the cable connections between D916 (X8) and single tank D907.
	Possible defects: D916; D927; D907.

ERR 39	Timeout during exposure (>t <sub>max</sub> )
System mode:	Explanation: D916 (CPU) detects a timeout during exposure (>tmax). If the exposure lasts longer than calculated, the exposure is interrupted by the system. This can occur if the mAs integrator on D916 (CPU) is defective.
Exposure	Action:
	Check the resonance frequency of the filament inverter TP - FC1 on D916 (CPU).
	Replace D916 (CPU).

ERR 41	Exposure not completed
System	Explanation:
mode:	☐> The exposure was interrupted via the hand switch.
Exposure	
	□ Remote control option: Fault / battery low

ERR 42	Filament current exceeds permissible limit
System mode:	Explanation: D916 (CPU) detects that the filament current is outside of the permissible limits (too low or too high) during "preparation" or an exposure.
	Action:
Exposure	Check the filament current at test point TP - IH on D916 (CPU).
	Check the maximum frequency of filament inverter FC1.
	Check the cable connection between D927 (X5) and the single tank.
	Check ribbon cable X11 (D927-D916).
	Possible defects: D916; D927; single tank.

ERR 43	Exposure release with activated motor drive
System mode:	Explanation: Exposure is not possible.
	Safety precaution to prevent exposures while the system is being moved by motor drive.
Exposure	

ERR 92	RAM error
System	Explanation: D916 (CPU) detects a RAM error.
status:	Action:
	Check the supply voltages of power supply U1.
Initializa- tion	⇔ Check fuses F7 and F8 on D927, relay K22 and the cable connections.
	Check the voltages at D916 X15.
	- +15 V D916 X15 pin 5-6
	15 V D916 X15 pin 6-7
	- +5 V D916 X15 pin 4-3

ERR 93	Voltage error of +15 Vcc	
System status: Initializa- tion	Explanation: D916 (CPU) detects a voltage error of +15 Vcc.  Action:  Check the voltages of power supply U1 and D916 X15.  +15 V D916 X15 pin 5-6  -15 V D916 X15 pin 6-7  +5 V D916 X15 pin 4-3	

ERR 96	kV converter error
System status:	Explanation: CPU board D916 is defective.
Initializa- tion	

ERR 97	mA converter error
System status:	Explanation: CPU board D916 is defective.
Initializa- tion	

ERR 98	I <sub>H</sub> converter error
System status:	Explanation: CPU board D916 may be defective.
Initializa- tion	

# Reading out the MOBILETT XP error memory

- Switch off the system and disconnect the power plug if necessary. Set the XP Hybrid operating mode switch to "0". Please observe all safety information.
- Remove the upper cover. Remove the XP Digital upper covers and place them on their sides on a table or similar surface. Do not disconnect any cables.
- Move switch SW2B on CPU board D916 to position 2 (service) ((Fig. 15 / p. 46)).
- Switch on the system.
- Service program Pr 1 is displayed on the control panel. Use the mAs +/- keys to select service program 3. Read out the error memory and make a note of the data (see the service programs section of these instructions).
- Subsequently set switch SW2B of D916 to position 1 (user) (Fig. 15 / p. 46).

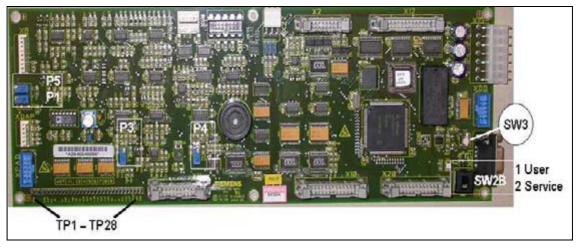


Fig. 15: CPU D916

Function Check 47

# Checking the line voltage supply

NOTE

In the case of error and for all planned dismantling, disconnect the supply cable to the capacitor charger (plug X3 on board D927).

For Hybrid/Digital, disconnect the four plugs of battery pack BK1-BK4 and the 300 V supply cable plug to the capacitor bank.

The "~" symbol must be lit on the control panel when the power plug is connected.

- Switch off the system and disconnect the power plug if necessary. (For XP Hybrid, the operating mode switch = "0").
- Measure the customer's power connection.
- Check the power plug.
- Open the upper cover and rear panel.
- Check the power cord between the plug and the line filter.
   First perform the test with the cable fully uncoiled, then as the cable is being coiled, and finally with the cable completely coiled.
- Remove the protective cover of D927.



**⚠ DANGER** 

There is a risk of a lethal electric shock when removing the safety cover in front of D927.

□ The voltages at fuse F5 of D927 can be up to 440 V!

- Check the cables from the line filter to D927.
- Check line fuses F7 and F8 on board D927 (F7/F8/Fig. 16 / p. 48).

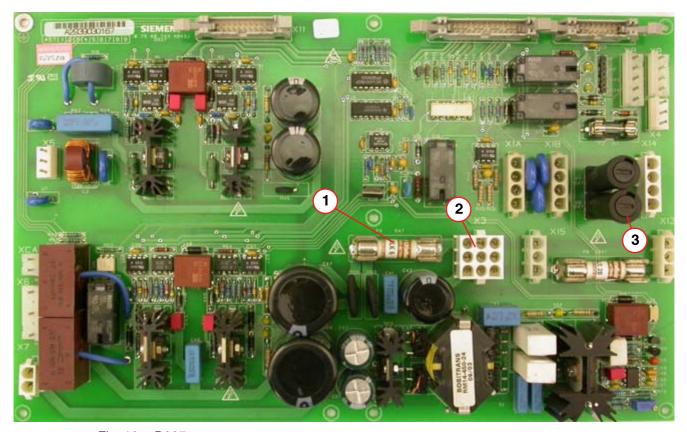


Fig. 16:D927Pos. 1F5Pos. 2X3Pos. 3F7/F8

Function Check 49

# Checking the intermediate circuit/capacitor bank



There is a risk of a lethal electric shock when troubleshooting at the capacitor bank. Be careful when removing the safety cover in front of D927 or when removing the capacitor bank.

□ In the case of an error, the voltage at individual capacitors C1-C12 can be > 40 V even after discharge of capacitor bank C1-C12 (approx. 25 minutes), regardless of the measured intermediate voltage.

#### NOTE

In the case of error and for all planned dismantling, disconnect the supply cable to the capacitor charger (plug X3 on board D927).

For Hybrid/Digital, disconnect the four plugs of battery pack BK1-BK4 and the 300 V supply cable plug to the capacitor bank.

In the case of an error, the capacitor bank must be completely dismantled. This work is described in the "Replacement of parts" instructions SPR8-230.841....

- Switch off the system and disconnect the power plug if necessary. In XP Hybrid, set the operating mode switch to "0". Please observe all safety information.
- Remove the covers in the following order: the upper cover first, then the rear cover, and finally all the side covers.
- Check or measure the current intermediate voltage with the system switched on (capacitor bank C10C12). Different checks are possible:
  - At test point D916 TP "VC" (13), (1 V^100 V)
  - At fuse F5 D927 against GND. The safety cover of D927 must be removed for this measurement.
  - Visual inspection of LED displays V1-V12 on board D972 of the capacitor bank (V/Fig. 17 / p. 50).
    - As long as an LED lights up, the assigned capacitor is still charged > 40 V (refer to Layout D972 of these instructions).
    - ☐ If one or several LEDs on D972 is missing, the capacitor bank must be dismantled completely. (See "Replacement of parts, MOBILETT XP").
- Check fuse F5 D927. Only measure and change the fuse when plug X3/D927 is disconnected and fuse F5 is voltage-free.

NOTE

The image in (Fig. 17 / p. 50) shows the capacitor bank in the uninstalled state. When installed, board D972 is only visible from the side.

With the system "ON", capacitors C1-C12 are charged to 440V ( $\pm 10\%$ ), V1-V12 light up a clear yellow. With the system "OFF" (Hybrid = "0"), capacitors C1-C12 are discharged. LEDs V1-V12 show the charge level of the capacitors > 40 V. Complete discharge takes approx. 15 to 20 minutes.

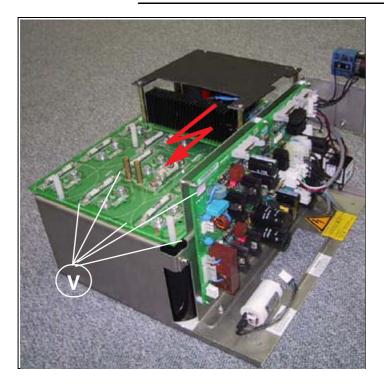


Fig. 17: D972 LED displays V1-V12

Function Check 51



Fig. 18: D927 capacitor voltage measurement

# **Battery unit (Hybrid/Digital only):**

NOTE

The MOBILETT may be turned on only if all battery packs BK1 - BK4 are connected to D982.

If one or more battery packs are not plugged in when the MOBI-LETT is turned on, fuse F3 and/or F4 on D982 fails.

24 batteries at 12 V/7 Ah Pb, grouped to form 4 battery packs (BK1-BK4), divided in the left blocks (BK1&BK2) and the right blocks (BK3&BK4), for the battery unit. Each battery block is assigned a charger of D982.

Charger 1 of D982 supplies left battery blocks BK1 & BK2. Charger 2 of D982 supplies right battery blocks BK3 & BK4.

A complete battery block must always be replaced in the case of an error.

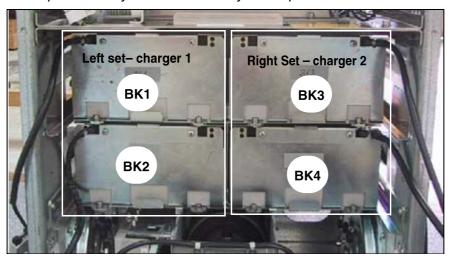


Fig. 19: Installed battery packages BK1-BK4\_01



Fig. 20: Single battery package

D916 (CPU) checks the charge level of the batteries via charger D982. LEDs are activated on the display of D908 (XP, Eco, Hybrid) (Fig. 21 / p. 53) or D909 (Digital) in accordance with the battery level.

Tab. 1 Battery charge level

Display	Information
V21, V22, V23 = "ON"	Batteries fully charged (100%)
V21, V22 = "ON"	Batteries 60-80% charged
V21 = "ON"	Batteries < 60% charged
V21, V22, V23 = "OFF"	Discharge batteries, no exposures possible, motor drive (Hybrid/Digital) possible, battery block voltage (left of right block) between 125V and 135V.
V20 = "ON" (red LED)	Batteries highly discharged, Err10 output, no exposures possible, motor drive possible, battery block voltage (left of right block) between 110V and 125V.

NOTE

If battery voltages of a battery block (left or right side) are < 110V, the MOBILETT XP (XP Hybrid/Digital) is turned off!

**NOTE** 

If battery voltages of a battery block (left or right side) are < 80V, the battery pack can no longer be charged and must be replaced.

NOTE

The battery voltage of a battery block (left or right side) is the total of the battery voltages of the given battery packs, BK1 + BK2 (left side) or BK3 + BK4 (right side).

To measure the battery voltage of a battery pack, pull out the appropriate plug (BK1 - BK4) and measure it at the plug.



Fig. 21: Board D908 user display

### Switch-on mode

The line voltage must be in the range of 110 V (+/-10%) or 230 V (+/-10%).

The line voltage is conducted via line filter Z1 to D927.

Board D927 distributes the required voltage via board fuses F7/F8 and control relay K22 to the system.

Power supply U2 is fed constantly when there is line voltage applied.

The system control unit (CPU) D916 and logical control unit D927 are supplied by power supplies U1 and U2 when system switch SW1 (key switch) is activated.

System initialization begins:

SW1 = ON

The following functions are integrated on board D927:

- Power distribution, (fuses F7 and F8)
- Switch-on circuit (fuse F3)
- Voltage supply to the capacitor charger (fuse F6)
- Supply for the intermediate circuit for anode start, filament circuit, and high-voltage (fuse F5)
- Collimator light

All functions are controlled and monitored by D916 (CPU).

For XP Digital, voltage supplies U3/U4 are switched on to supply 220 V AC to the CXDI PC, power box, and touchscreen.

The main system functions are activated during initialization of D916 (CPU). The main functions are:

- Charging of the capacitors
- Preparation of the filament circuit
- Preparation of the high-voltage circuit

After conclusion of initialization, the system shows the preferred values for kV and mAs and is ready for operation.

# Mode of operation of the capacitor bank

Capacitor bank D972 generates the intermediate circuit voltage for the HV inverter, filament inverter, and anode starter modules.

Capacitor bank D972 is continuously charged by capacitor charger D952.

Capacitor bank D972 consists of 12 capacitors connected in parallel that deliver sufficient energy to operate the inverter. Each capacitor is connected in series with a fast fuse. Each capacitor has a capacity of 10 mF. The total capacity is 0.12 F. To facilitate handling of these live components, the LEDs at the capacitors show the charge level > 40 V.

When the system is "OFF", the capacitors are discharged via three resistors (R3, R4, R5) within 15-20 minutes.

The charging time of the capacitors varies depending on the charge level of the capacitor bank. Around 7 to 9 seconds are required for charging empty capacitors.

The intermediate circuit voltage of the capacitor bank is monitored by D916 (CPU).

In the case of an error, the charging procedure is interrupted.

When replacing one or more capacitors of the capacitor bank, all capacitors must have a voltage value of < 2 V to avoid outage of the fast fuses on D972.

## Mode of operation of the anode starter

The anode starter on D927 is fed by the intermediate circuit voltage of the capacitor bank.

The "preparation" function causes the rotating anode to start up (150 Hz). The anode runs freely during the exposure. The started anode stator is not supplied with voltage. At the end of exposure, the anode is braked.

The anode starter is controlled by D916 (CPU).

The rotating anode motor in the single tank functions as a single-phase motor with a phase-shifted auxiliary phase via capacitor C2.

The anode starter is not activated in standby.

D916 monitors the motor current through measuring signals TP-I1 and TP-I2 and thus protects anode operation. If a phase is missing or the motor current is outside the permitted range, the system interrupts the anode starting function and brakes the anode.

The braking process of the anode rotation lasts around 5 seconds. The system subsequently switches over to standby.

# **High-voltage circuit**

### Principle of operation

The high-voltage circuit is to reach the selected high-voltage as quickly as possible and keep it constant during the exposure.

The high-voltage circuit is made up of the following components:

- D916 (CPU)
- Main inverter on D962
- Oscillating circuit capacitor C1
- High-voltage transformer in the single tank
- D907 measurement data log
- Intermediate circuit, capacitor bank D972

The high-voltage inverter is not active in standby.

With "exposure preparation", the nominal kV of D916 is output (measurable at TP-KVS D916).

During exposure, D916 controls and monitors the high-voltage.

The high-voltage can be measured as test points TP-KVN, TP-KVP (1 V = 10 kV) and TP-KV (1 V = 30 kV, total kV) on D916.

#### Possible error messages of the high-voltage circuit:

ERR 4 Static short-circuit at the main inverter

ERR 8 Static kV measured value <> 0

ERR 31 kV exceeds permissible limit

ERR 34 X-ray current exceeds permissible limit (tube short-circuit)

ERR 35 Short-circuit at the main inverter

ERR 37 Error in the kV control loop

### Sample high-voltage measurements

#### Positive/negative high-voltage measurement

- Switch off the system
- Remove the top cover and, in the case of MOBILETT XP Digital, place it on its side on a table or similar surface (do not disconnect any cable connections)

- Oscilloscope channel 1 at D916 TP "KVP" (4) and D916.GND (1), channel 2 at D916 TP "KVN" (3)
  - Oscilloscope setting: channel 1 = 2V/div, channel 2 = 2V/div, trigger channel 1, trigger stage 1.5 V, 500  $\mu s/div$
- Switch the system on
- Select 121 kV, 5 mAs on the control panel (For Digital, first switch to the manual operating mode)



- Release an exposure
  - □ Below is the oscillogram of the positive and negative high-voltage values

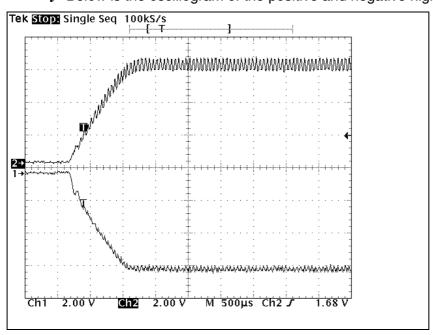


Fig. 22: Exposure\_kVp\_kVn\_2

### Sample error with tube short-circuit ERR 34

- Switch off the system
- Remove the top cover and, in the case of MOBILETT XP Digital, place it on its side on a table or similar surface (do not disconnect any cable connections)
- Oscilloscope channel 1 at D916 TP "KVP" (4) and D916.GND (1), channel 2 at D916 TP "KVN" (3)
  - Oscilloscope setting: channel 1 = 2V/div, channel 2 = 2V/div, trigger channel 1, trigger stage 1.5 V, 1 ms/div
- Switch the system on
- Select 133 kV, 2 mAs on the control panel (For Digital, first switch to the manual operating mode)



- Release an exposure
  - □ Below is the oscillogram of the positive and negative high-voltage values

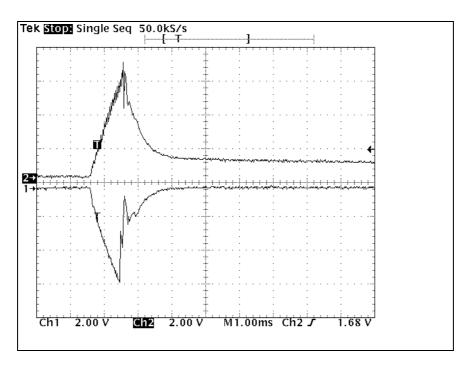


Fig. 23: Exposure\_kVp\_kVn\_s

### Setting the highest frequency for the main inverter (50 kHz)

- Switch off the system
- Remove the top cover and, in the case of MOBILETT XP Digital, place it on its side on a table or similar surface (do not disconnect any cable connections)
- Remove the metal plate over board D916 For MOBILETT XP Digital, remove the CXDI PC (laptop) and also remove the holder plate
- Oscilloscope channel 1 at D916 TP "FC2" (26) and D916 TP "GND" (1)
   Oscilloscope setting: 1V/div, sweep 5 μs/div
- Move switch SW2B on D916 to 2 (service program) and switch the system on
- Select service program 7
- Use exposure switch S27 to press and hold "PREP"
- Set the resonance frequency of the main inverter via potentiometer P4 on D916 to 50 kHz +/-0.5 kHz (Fig. 24 / p. 60)

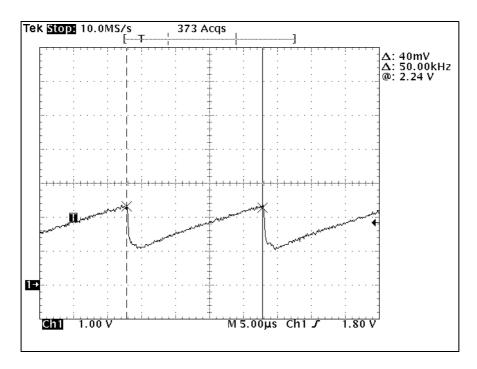


Fig. 24: FC2\_50kHz

### Filament circuit

### Principle of operation

The filament circuit controls standby heating, preheating in the preparation phase, and the tube current during exposure.

The filament circuit is made up of the following components:

- D916 (CPU)
- Filament inverter on D927
- D907 measurement data log
- Filament transformer/heating coil for the single tank
- Intermediate circuit, capacitor bank D972

In standby and during preheating, the primary current of the filament transformer is obtained from D916 (CPU) (TP I / D916 (1 V = 1A)). The effective primary current is converted into IH and regulated by the target IHS value (TP IH / D916 (1 V = 2 A)).

During an exposure, D916 (CPU) controls the filament circuit via the tube current.

The exposure is performed with a decreasing load, reduction in the tube current.

Maximum exposure output:

Tab. 2 Maximum output for different exposure times

ms	KV	KW
0-10	>= 81	30
10-100	>= 81	25
0-100	< 81	25

Possible error messages for the filament circuit:

- ERR 6, filament inverter frequency error
- ERR 7, invalid primary filament current
- ERR 9, invalid tube current, mA <> 0
- ERR 12, short-circuit of the filament inverter
- ERR 15, static short-circuit of the filament inverter
- ERR 22, short-circuit of the filament inverter
- ERR 23, filament current exceeds permissible limit
- ERR 34, tube current exceeds permissible limit
- ERR 36, short-circuit of the filament inverter
- ERR 38, error in the mA control loop
- ERR 42, filament current exceeds permissible limit

### Sample heating measurements

### Measuring the standby heating

- Switch off the system
- Remove the top cover and, in the case of MOBILETT XP Digital, place it on its side on a table or similar surface (do not disconnect any cable connections).
- Oscilloscope channel 1 at D916 TP "I" (7) and D916.GND (1) resonant filament current.

Oscilloscope setting: channel 1 = 2 V/div, trigger channel 1, trigger stage 1.5 V, 100  $\mu s/div$ 

- Switch the system on
  - ⇔ Below is the oscillogram of the resonant filament current during standby

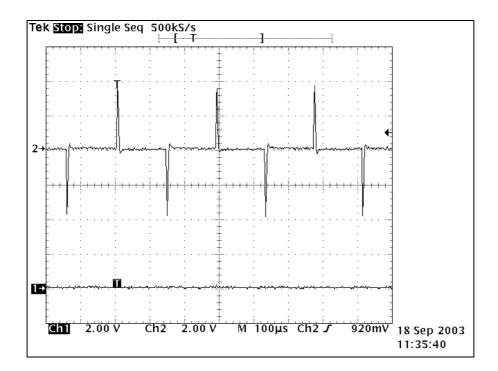


Fig. 25: Stand\_by\_operation\_ih\_ir

NOTE

The oscillogram below shows a single oscillation (shorter time base) of the resonant filament current during standby.

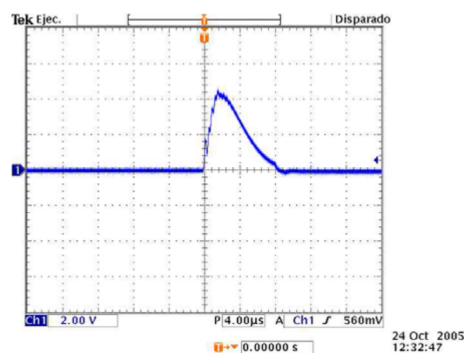


Fig. 26: Stand By\_I

#### Setting the highest frequency of the filament inverter (75 kHz)

The settings are made via a 2-channel oscilloscope and potentiometer P3 of D916 (CPU).

- Switch off the system
- Remove the top cover and, in the case of MOBILETT XP Digital, place it on its side on a table or similar surface (do not disconnect any cable connections).
- Remove the back cover of the MOBILETT XP (Access to D927)
- Remove the metal plate over board D916 For MOBILETT XP Digital, remove the CXDI PC (laptop) and also remove the holder plate
- Oscilloscope channel 1 at D916 .FC1 (TP25) and D916.GND (TP1)
   Oscilloscope setting: 1V/div, sweep 5 μs/div
- Remove the protective cover of D927 Caution! It is possible to come into contact with components under voltage!
- Disconnect plug X5 of board D927 (breaking the filament circuit)
- Move switch SW2B on D916 to 2 (service program) and switch the system on
- Select service program 9
- Use exposure switch S27 to press and hold "PREP"
- Set the resonance frequency of the filament inverter via potentiometer P3 on D916 to 75kHz +/- 2 kHz

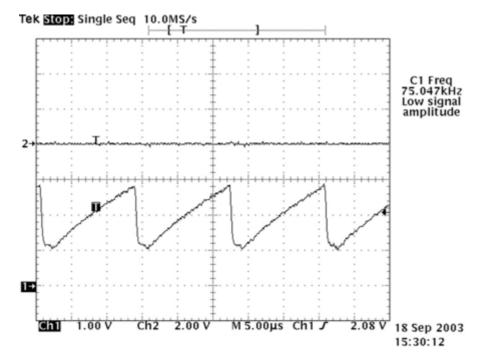


Fig. 27: Test point FC1 75 kHz

### **Measuring preheating**

- Switch off the system
- Remove the top cover and, in the case of MOBILETT XP Digital, place it on its side on a table or similar surface (do not disconnect any cable connections).
- Oscilloscope channel 1 at D916 TP "I" (7) and D916.GND (1) resonant filament current
  - Oscilloscope setting: trigger channel 1, trigger stage 1 V, 2 V/div, sweep 100 µs/div
- Select 81 kV and 5 mAs on the control panel In the case of XP Digital, switch to the manual operating mode
- Use exposure switch S27 to press and hold "PREP"
  - □ Below is the oscillogram of the resonant filament current during preheating

**NOTE** 

See the "MOBILETT XP, Replacement of parts" instructions for information on setting the filament current on the D916.

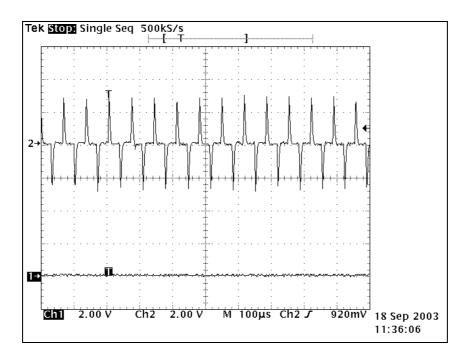


Fig. 28: Preparation\_ih\_ir

**NOTE** 

The oscillogram below shows a single oscillation (shorter time base) of the resonant filament current during preheating.

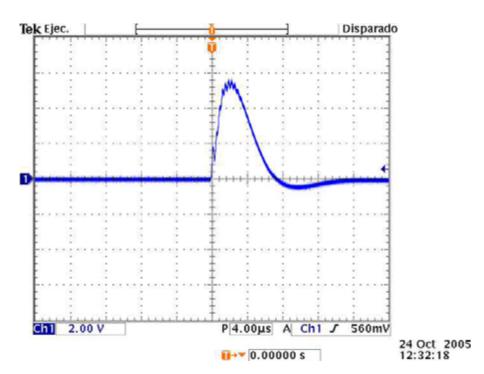


Fig. 29: Vorbereitung\_I

### Measuring the exposure (mA and kV)

- Switch off the system
- Remove the top cover and, in the case of MOBILETT XP Digital, place it on its side on a table or similar surface (do not disconnect any cable connections).
- Oscilloscope channel 1 at D916 TP "KV" (5) and D916 TP "GND" (1), channel 2 at D916 TP "JR" (6)

Oscilloscope setting: channel 1 = 2 V/div, channel 2 = 1 V/div, trigger channel 2, trigger stage 1 V, sweep 20 ms/div

- Switch on the system
- Select 81 kV, 40 mAs on the control panel (For Digital, first switch to the manual operating mode)



- Release an exposure
  - ⇒ Below is the oscillogram of the high-voltage and the tube current

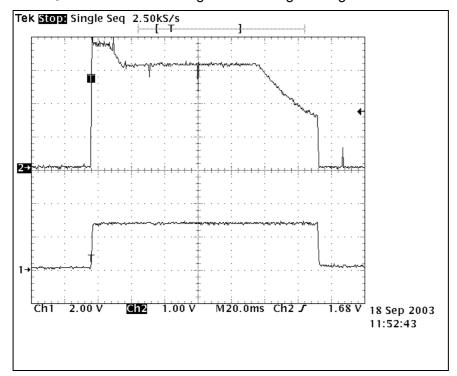


Fig. 30: Exposure\_kV\_ir5

### mAs counter

The tube current acquired on board D907 is conducted to a voltage frequency converter on D916 (CPU).

This converter generates a proportional frequency with a ratio of 100 mA = 16 kHz. The output impulses can be measured by the oscilloscope at test point F1 on D916. The impulses are digitally integrated to count the necessary mAs value.

The mAs counter switches the exposure off when the set mAs values are reached and switches to standby.

If the time limit of 3 or 5 seconds is reached prior to mAs switch-off, the exposure is canceled and an error message is output.

### **Overview**

### **Activating service programs**

- System OFF
- Remove the top cover.
- Service switch SW2B on board D916 in position 2
- System ON.
  - □ Display shows "Pr 1"
- Use the "mAs+/mAs-" keys to select the service program
- Use the Collimator Lamp button on the control panel to start a service program. To end a service program, press the Collimator Lamp button again.

**NOTE** 

If a service program is activated, no radiation can be released.

### Program 1 - formatting the capacitor bank

#### **Program 1**

- After the start of the service program, "CAP 150" is shown on the display.
- The voltage rises incrementally from 150 V to 440 V DC. Each program step is performed for approx. 6 minutes.
- The system maintains the voltage level of 440 V DC for approx. 1 hour. The program
  is then ended automatically. After termination of the program, the message "CAP
  END" is displayed.

#### NOTE:

If the actual voltage is greater than 150 V, the program first performs a discharge to < 150 V. This process takes 10 to 15 minutes. The program then begins charging the capacitor bank.

### **Program 2 - Exposure counter**

#### Program 2

Display of exposure number in the display

#### NOTE:

It is not possible to reset to zero in the event of a tube change.

The counter reading must be noted as the starting value for a new component (e.g. single tank).

### **Program 3 - Error log**

### **Program 3**

- Shows an error list of the last 20 error messages.
- The left section shows how many error messages were logged.
- The error codes are shown in the right section.
- The latest error message is shown first.
- Use the mAs +/- keys to display the next error messages.

### Program 4 - Deletion of the error log

#### **Program 4**

Keep the kV+ key pressed for approx. 4 seconds to delete the error list.

### Program 5 - changing the preferred values for kV & mAs

#### **Program 5**

- After the start of the service program, "LAS VAL" is shown on the display.
- The "Last Value" function can be activated with the "Collimator Lamp" button.
- The standard exposure parameters can be selected via the kV+/kV- and mAs+/mAskeys.
- Use the Collimator Lamp button to save these values and to end the program.

## Program 6 - Display of the maximum values (KV & mAs)

#### **Program 6**

- The maximum exposure parameters can be selected/established via the kV+/kV- and mAs+/mAs- keys.
- Collimator lamp button to save these values and to end the program.

The maximum exposure parameters can be individually programmed for all operating modes (line operation 110 V, line operation 230 V und battery operation (Hybrid)).

Switch the (Hybrid) operating mode switch to line operation or battery operation prior to switching the system on.

For mains operation, you must ensure that the programmed values are valid only for the given line voltage (110V or 230V) on site.

### Program 7 - setting the maximum main inverter frequency

### **Program 7**

- After the start of the service program, "ADJF" is shown on the display.
- Measure F (max) at the test point TP-FC2 on D916.
- Set exposure switch S27 to "preparation".
- set the frequency of the main inverter with potentiometer P4 at D916.
   (Turn counter-clockwise Increase).
  - Set value TP-FC2 is 50 kHz +/-0.3 kHz

### Program 8 - Anode starter - start/stop test

#### **Program 8**

- "ROT220" (rotation 220/sec.) is displayed on the display.
- Set exposure switch S27 to "preparation". The anode starter is activated. The anode accelerates.

### Program 9 - Filament current test

#### **Program 9**

- After the start of the service program, "FIL3" is shown on the display.
- Set exposure switch S27 to "preparation". Preheating begins. "FIL5" is shown on the display as long as exposure switch S27 is pressed.

## Program 10 - AutoOff on/off (Hybrid/Digital in battery mode)

#### Program 10

- After the start of the service program, "ON" or "OFF" is shown on the display.
- ON = automatic switch-off after approx. 15 minutes of inactivity (default factory setting: Hybrid = ON, Digital = OFF)
- Use the mAs+ or mAs- keys to switch over.

#### NOTE:

If the battery voltage is less than 110 V (right or left side), the system is always switched off (Hybrid and Digital).

### **Program 11 - Exposure points**

### Program 11

- After the start of the service program, "ON" or "OFF" is shown on the display.
- ON = 49 (for ECO = 47) exposure points possible (default factory setting); OFF = 25 (for ECO = 24) exposure points possible
- Use the mAs+ or mAs- keys to switch over.

### Program 12 - system type

#### Program 12

- After the start of the service program, system information is shown on the display.
   E.g.:
  - "DIG 102" = Digital, 102 = Firmware VA00B (A = 1, B = 2, ...)
  - "103" = XP Hybrid, 103 = Firmware VA00C
  - "ECO 102" = ECO, 102 = Firmware VA00B

### Program 13 - sound level of the keyboard

#### **Program 13**

- After the start of the service program, "bep1", "bep2", or "bep3" is shown on the display.
- bep1 = quiet; confirmation tone upon pressing the "kV," "mAs," or "collimator lamp" keys is OFF (factory default setting).
- bep2 = quiet; confirmation tone upon pressing the "kV," "mAs," or "collimator lamp" keys is ON
- bep3 = loud; confirmation tone upon pressing the "kV," "mAs," or "collimator lamp" keys is ON
- Use the mAs+ or mAs- keys to change this.

Chapter	Section	Revision
All chapters	n.a.	Editorial changes.
Test Points, Fuses and LEDs	Test points D916 (CPU)	Test points 'I', 'IH', and 'IHS' corrected or expanded.
Test Points, Fuses and LEDs	D982 (battery charger)	Errors deleted; more information added
Error messages	n.a.	Explanations of 'ERR3 and 'ERR11' corrected
Function check	Battery module	Completely rewritten
Basic functions	Filament circuit	Completely rewritten
Service programs	Program 13	Adapted to the latest FW